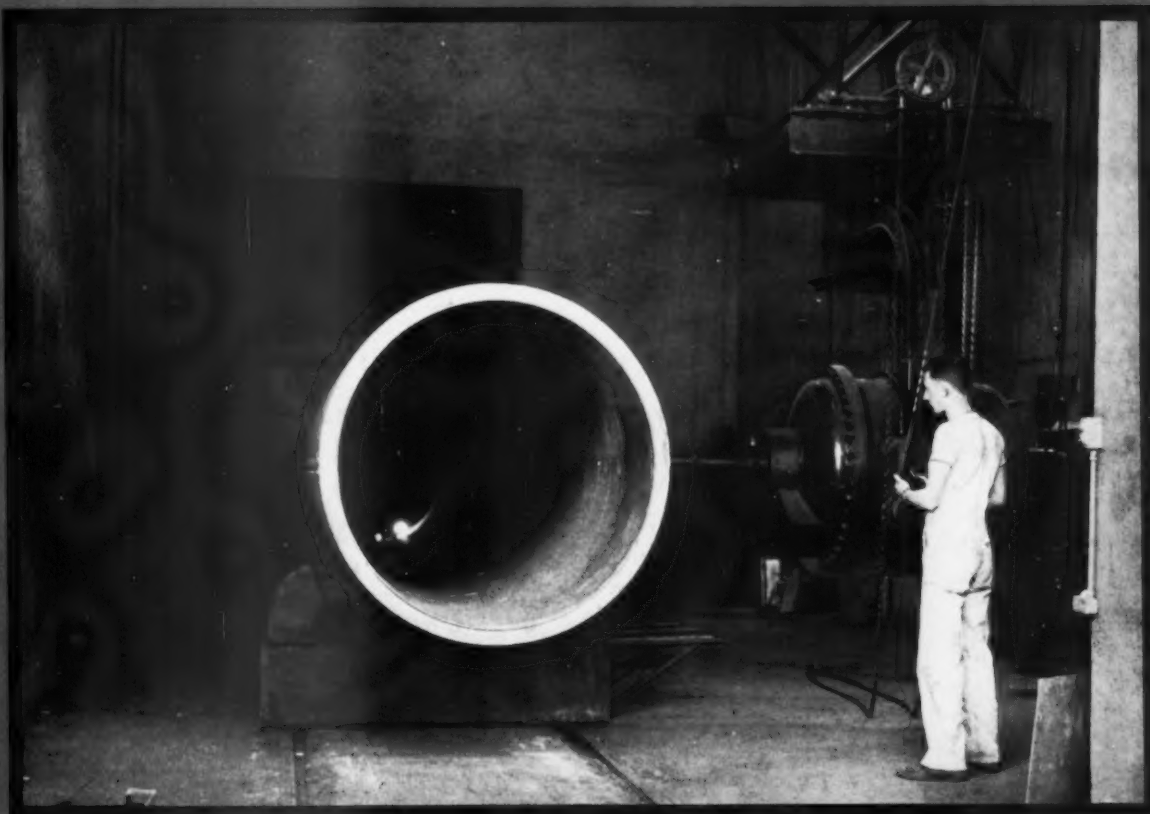
COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

September, 1943



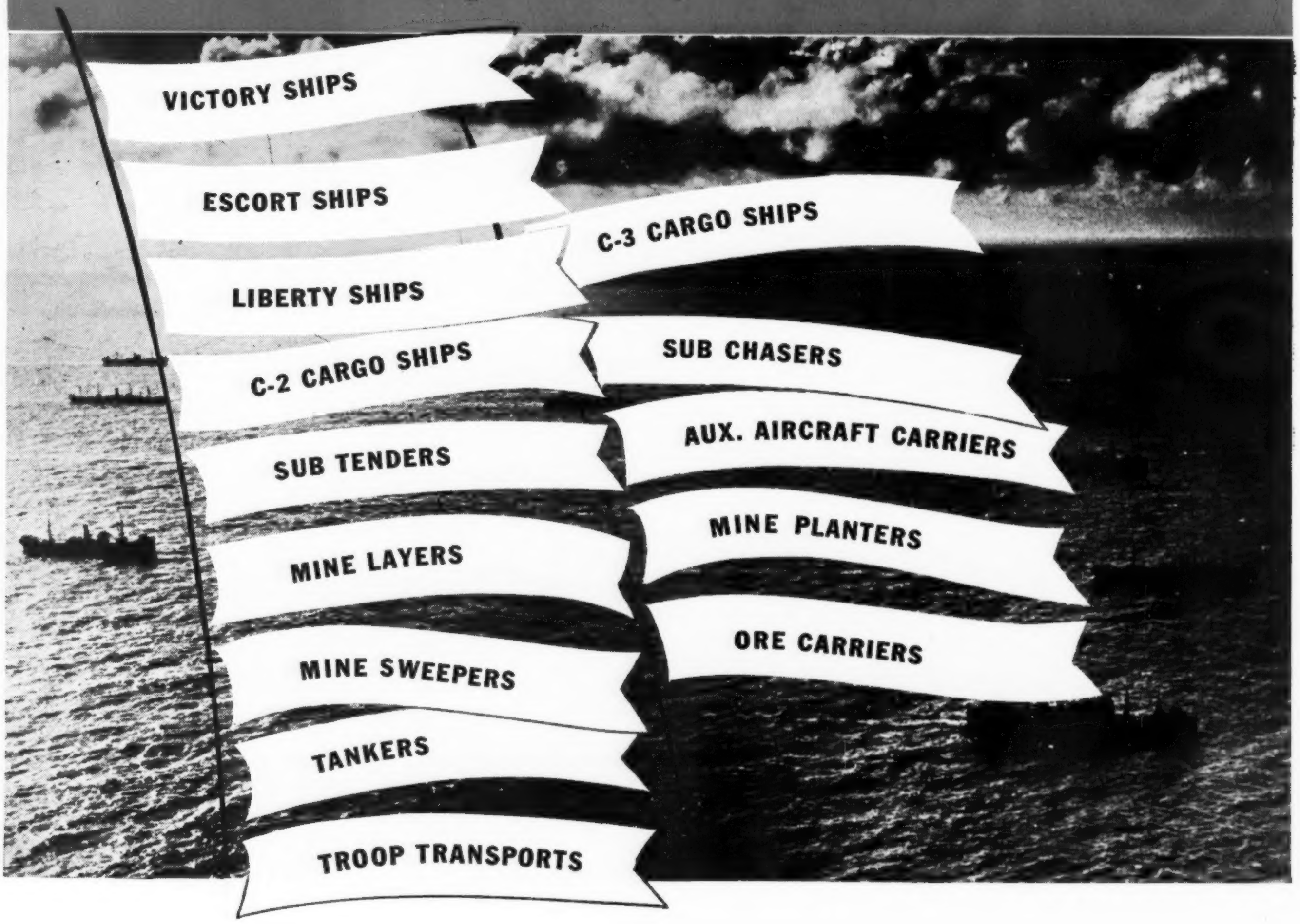
Longitudinal weld of boiler drum set up for X-raying at 1,000,000 volts

Collection and Disposal of Fly Ash from Spreader Stokers

Topping Program at SHERMAN CREEK — Turbine-Generator and Auxiliaries

Ships that sail the seven seas...

Are powered by C-E boilers!



★ This list of merchant and naval vessels indicates the large part assigned to Combustion Engineering in the greatest shipbuilding program of all time. All of these classes of ships are included in contracts for boilers awarded to C-E during the past two and a half years — but even more impressive than their variety is their volume, the principal part of which is represented by the six types of cargo ships listed. When present contracts are completed, an aggregate of over 12,000,000 dead weight tons of cargo shipping will be powered by C-E Boilers. This is in excess of the dead weight tonnage of our country's entire pre-war merchant fleet.

In a war where so much depends on shipping, C-E employees from top to bottom are grateful for the opportunity of making so large a contribution to the vital task of keeping American ships moving through the seven seas. A-743-B

COMBUSTION ENGINEERING

200 Madison Avenue, New York 16, N. Y.

COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME FIFTEEN NUMBER THREE

CONTENTS

FOR SEPTEMBER 1943

FEATURE ARTICLES

EDITORIALS

DEPARTMENTS

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EDITORIAL

F. H. Rosencrants

The sudden death of F. H. Rosencrants on August 26 was not only a shock to his associates and many friends in the field, but was a distinct loss to the profession to which he had contributed much. Possessed of a thorough technical background, amplified by wide power plant experience both in this country and abroad, he had advanced to the front rank of authorities on steam generating practice. His engineering thinking was tempered by a keen sense of values, ability to arrive at a decision and carry through to a successful conclusion, and a desire to promote progress within the scope of commercial practicability. As an executive he displayed exceptional ability as an organizer and an appraiser of men to form a smooth functioning group, with the result that he always found time to assist others who sought his counsel.

Aside from his identification with stationary boiler practice, Mr. Rosencrants had contributed to advancement in the field of chemical recovery in the paper industry; he had a leading rôle in the application of forced circulation to large high-pressure steam generating units; and, since our entry into the war, as head of his company's marine department, had been responsible for vast numbers of marine boilers for the Maritime Commission and Navy.

His numerous papers before the A.S.M.E. and other engineering societies, as well as two World Power Conferences, have served to enrich engineering literature in his particular field; and it may be recalled that in 1928 he was the recipient of an award from the British Institute of Electrical Engineers for the year's outstanding paper, covering "Practice and Progress in Combustion of Coal for Steam Generation."

Held in high esteem, both as an engineer and as an individual by those who knew him, his passing at the height of an eminent career leaves a gap that will long be felt.

Marine Engineers

The tremendous expansion of our merchant marine has called for a large number of marine engineers. Although many have been trained to date through intensive courses in schools established by the War Shipping Administration, there is still need for men experienced in operating the power plants of ships. With the knowledge that there are many men operating stationary plants who have had experience afloat, the Government set about several months ago to recruit those that might be available. It is reported that this effort met with an encouraging response. However, without minimizing the urgent needs of our merchant marine, it might be pointed out that it is equally important not to jeopardize operation of stationary plants upon which war production is so dependent.

Limited Rationing of Bituminous Coal

In order to maintain the necessary coal requirements for the production of coke, the manufacture of gas, for foundry and metallurgical purposes, the manufacture of chemicals, and to meet scheduled lake shipments during the balance of the navigation season, the Solid Fuels Administration has directed a general curtailment of rail shipments of bituminous coal to all other consumers. The producing districts affected by the order comprise sections of Pennsylvania, Maryland, West Virginia, Ohio, Kentucky, Virginia and Tennessee. The reductions, which range from 25 per cent, in the case of customers having more than minimum amounts of coal in stock, to 40 per cent of current monthly consumption for retail dealers, are predicated on the amount that the customer has in storage.

It will be recalled that since early last spring Secretary Ickes has repeatedly urged the storage of coal during the off season. While many plant managements heeded his advice, the suspension of production during the coal strike and the dislocation of deliveries for some time thereafter cut heavily into many storage piles. Although the average on hand for all industries, as of August first, was 52 days' supply, some were as low as 24 days' and many individual plants are undoubtedly much below this figure. The electric utilities, which have always been farsighted in this respect, had their average storage reduced during the month of July from 94 to 89 days' supply, whereas during the same period their consumption increased 7.6 per cent.

Purchasers of bituminous coal for power generation who have more than 60 days' supply on hand will in no case receive more than 75 per cent of their current monthly requirements. On this basis their storage piles should serve to make up the difference for a period of eight months at the current rate of consumption. It is possible, however, that in some cases customers will be unable at present to acquire their full allotments under the plan, for the order directs that producers in certain districts must first meet their commitments for metallurgical coke and the Great Lakes trade before filling other orders.

It will be recalled that the late opening of navigation on the Great Lakes last spring was responsible for unusual depletion of stocks and the Government is quite properly taking steps to assure an adequate supply for those regions.

This limited rationing of coal is not likely to cause many hardships, especially as it appears to be a more or less temporary expedient and comes at a time when a nationwide industrial conservation drive is scheduled to be launched. It does, however, emphasize the fact that even such a bountiful resource as coal has its restrictions during wartime.

Topping Program at SHERMAN CREEK Part II—Turbine-Generator and Auxiliaries

By H. KNECHT Division Engineer,
Consolidated Edison Co. of New York, Inc.

Part I, which appeared last month under the authorship of R. T. Roberts, discussed the high-pressure steam generating equipment of the extension to this station. The present article deals with the main high-pressure turbine-generator and its auxiliaries, the feedwater heating, the boiler-feed pumps and their controls and the station heat balance. Briefly, the installation consists of a million-pound-per-hour boiler supplying throttle steam at 1600 psi, 950 F to a 50,000-kw high-pressure turbine-generator which exhausts at 200 psi 485 F to the low-pressure turbines. The ultimate plan calls for four such high-pressure units which will supply the full steam requirements of the existing eight low-pressure units whose combined capacity will approximate the high-pressure capacity.

THIS installation incorporates several features of special interest. The turbine is the largest unit of its type considering its rating, pressure and temperature. The million-pound-per-hour boiler feeds steam at 1600 psi 950 F to the turbine through a single 12-in. lead in which the usual costly gate valve has been omitted. The vertical expansion in the steam lead, which rises about 60 ft from the turbine stop valve to the superheater header, is directed upward from an anchor at the turbine. This expansion is taken up in the long, horizontal, flexible superheater tubes that tie into the spring-supported superheater header. The calculations for stress, due to expansion in the high-pressure steam, exhaust and extraction lines, were checked by the use of scale model tests.

Control of feedwater to the boiler is handled by a three-element system, in which water flow, steam flow and drum level changes combine to vary the speed of the boiler feed-pump turbines. The usual boiler-feed control valve has been omitted thus reducing cost and saving feed-pump horsepower.

In operation it was found possible to run the turbine exhausting into the 200-psi station header as soon as a pressure of 400 psi was obtained in the high-pressure boiler. Starting time is therefore considerably less than that required on similar turbines on the system. Since the gland steam leak-off is tied into the sub-atmospheric direct-contact heater as soon as possible after starting, the only steam lost to atmosphere is a relatively small amount blowing through the casing drains on the turbine. These are closed as soon as the machine operates against 200 psi back pressure.

A relatively short turbine foundation, built of concrete, has reduced the effect of vibration considerably.

The generator design incorporates a flexibly supported armature core to minimize double frequency vibration. This is accomplished by suspending the armature core in such a way that it can move radially with considerable freedom but is rigid in the direction of torque load.

Following the policy used in our previous topping installations, all the piping has been generally laid out in a simplified and streamlined manner eliminating costly bypasses, extra valves and cross-connections. This has been accomplished, to a large degree, by the grouping together of equipment tied together with piping.

To eliminate glare and improve its appearance, the turbine gage board is equipped with integral indirect lighting. The fluorescent tubes are mounted at points on the back of the false front panels which are hinged for access to the instruments.

Completion and placing into satisfactory operation of this unit under difficult wartime conditions, was made possible by cooperation of the Edison Company's Construction and Shops Department with the turbine manufacturer. Although all of the material for the turbine-generator was complete at the manufacturer's plant, our shops machined the turbine spindle and fabricated the main oil reservoir, oil piping, governor linkage and other miscellaneous parts. In addition, the turbine was first assembled and fitted on the foundation and the preliminary run and adjustments performed in the field. This departure from the usual assembly and test at the manufacturer's shop worked out very satisfactorily.

Turbine-Generator

The turbine-generator, manufactured by the Westinghouse Electric & Manufacturing Company, is rated at 50,000 kw at 0.8 power factor, 13,800 volts, 60 cycles, 3-phase and operates at 3600 rpm. Design steam conditions are 1600 psi 950 F at the throttle, 400 psi at the bleed point and 200 psi 485 F at the exhaust.

As indicated in the cross-section Fig. 2 the turbine is a single-cylinder machine with an impulse stage followed

by sixteen reaction stages. The latter are designed with constant diameter at mean-blade heights to obtain practically constant net axial unbalanced steam thrust and thrust-bearing load.

Six control valves are provided, five admitting steam to different sections of the impulse stage nozzles, the ixth or overload valve admitting steam to the eighth stage. This internal bypass valve is under the control of the governor and opens only when the normal capacity of 50,000 kw handled by the first five valves is insufficient. The maximum overload capacity is 56,250 kw. The steam chest which carries the six admission valves is cast integrally with the cylinder cover, thus eliminating a high-pressure steam joint.

to maintain alignment with the generator. The pedestal between the turbine and generator is stationary, while that on the governor end is of the lubricated sliding-foot type.

The governing system is the full hydraulic oil-actuated type similar in design to that used on the other Westinghouse topping units on the Company's system. In addition to the speed-responsive and emergency-tripping elements, a 200-psi back-pressure control is provided on the main turbine exhaust to limit back pressure to a predetermined maximum in the event of disturbing conditions in the low-pressure steam system. Control of back pressure is normally handled by the high board operator who regulates load on the low-pressure turbines to maintain approximately 200 psi in the low-pressure

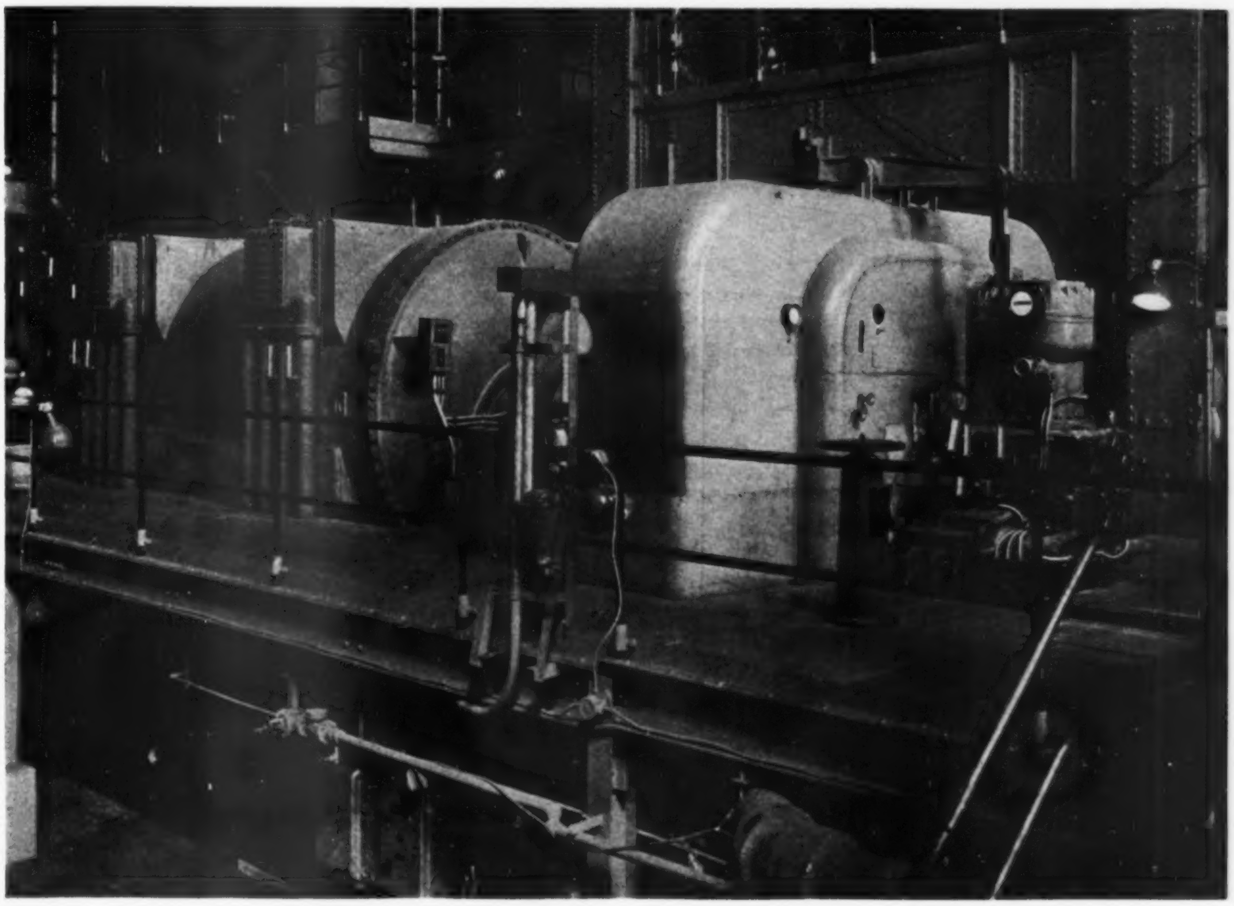


Fig. 1—Main high-pressure turbine-generator of 50,000 kw capacity

One of the design features is an annular steam belt extending around the entire cylinder at the inlet end. This chamber serves as the passage between No. 1 valve located in cylinder cover and its nozzle located in the base. It therefore is filled with high-temperature steam as soon as the first valve opens and helps to reduce distortion of the casing during warming and starting up. For simplification of the cylinder castings, the lower half nozzle chamber has been made a separate casting supported in the cylinder much the same as the separate reaction blade rings.

The cylinder is mounted on pedestals designed to provide approximate center line support. The turbine is free to expand in all directions from the anchor at the exhaust connections, and longitudinal keys are provided

steam system. An unusual rise in back pressure actuates the back-pressure control which, in turn, closes the admission valves.

For suitable protection and supervisory control the turbine is equipped with several devices. A watt-type reverse-power relay is provided and designed to give an alarm should motoring occur—a condition that might cause overheating of the blades. In accordance with our practice, the high board operator is instructed to remove this unit from the line when the load has dropped to 2000 kw.

Opening of the control valves may be limited by manual operation of a load-limit valve. Such limitation of load may be desirable if either the turbine or the boiler capacity is below normal, in which case the genera-

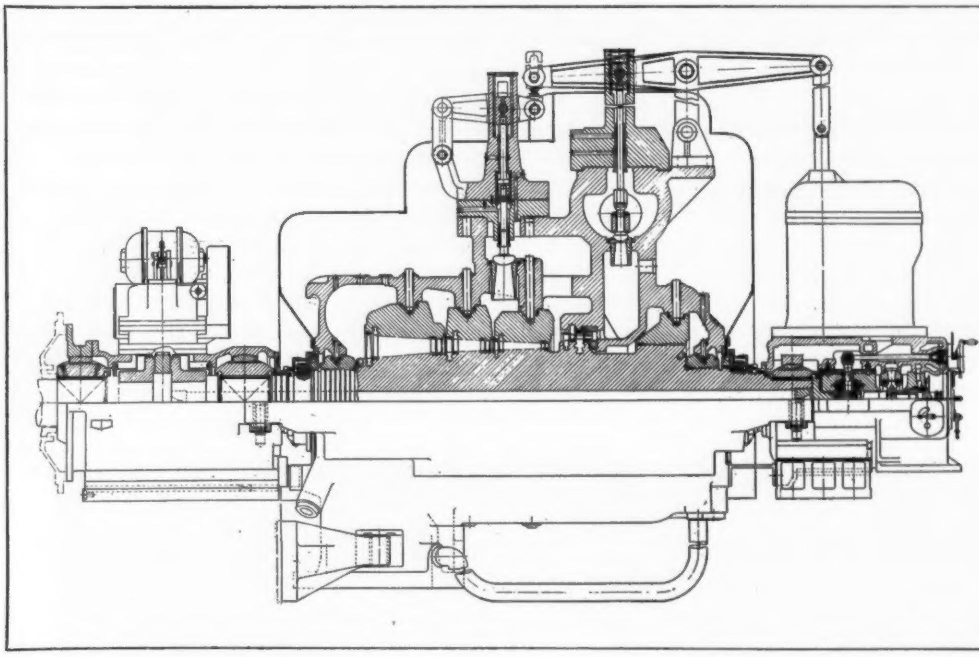


Fig. 2—Section through main turbine

tor should not be free to pick up load in the event of a sudden decrease in system frequency.

A turbine-shaft position indicator and recorder is installed to indicate the relative axial position of the rotor thrust runner with respect to the thrust bearing support. This device gives the operator instantaneous readings of the rotor position at all times and sounds an alarm if the rotor moves beyond a predetermined distance, such as might occur from abnormal thrust.

A vibration meter has been installed to detect and record unusual and normal vibration amplitudes occurring at points adjacent to the bearings. This apparatus consists of shaft pick-up to detect vibration, an amplifier and a recorder.

The generator is of the hydrogen-cooled type with integral fans and internal gas coolers. It is capable of delivering rated kva output at all terminal voltages from 13,200 to 14,500 volts. With air cooling, the capacity of the generator would be limited to 35,000 kva. Approximately 50,000 cfm of gas is required for ventilation. Normal rise in the armature at full rating is 60 C, and in the field 85 C.

Excitation is provided by a direct-connected exciter and pilot exciter. The former is rated at 200 kw, 250 volts dc, and the latter at 3 kw, 250 volts dc.

The generator housing will withstand a pressure of 100 psi without failure. This exceeds the pressure which would result from an explosion of the enclosed hydrogen.

The control system is entirely hydraulic, using part of the lubricating oil as the actuating medium. The main oil pump is of the centrifugal type, mounted on the shaft. Part of this oil supplies the speed governing impeller which is also mounted on the turbine shaft. The pressure in the chamber around the governor impeller is maintained by centrifugal force and varies with the square of the speed. The speed controlled governing pressure acts on a pressure transformer which magnifies governing pressure changes $3^1/_2$ to 5 times. The magnified or secondary pressure actuates the governor servo-motor relay and thereby opens or closes the control valves.

The remainder of the oil discharged by the main oil pump flows to the main oil reservoir where part of it goes through ejectors which deliver oil from the reservoir to the pump suction. The remaining high-pressure oil is reduced in pressure and then goes through the oil coolers to the bearings. Oil from the bearings is drained into the reservoir.

A vertical steam-turbine-driven centrifugal auxiliary oil pump is provided to furnish oil when starting, stopping or in emergency. This pump is started automatically by an oil-pressure-actuated governor in case of failure of normal bearing oil supply or it may be started by

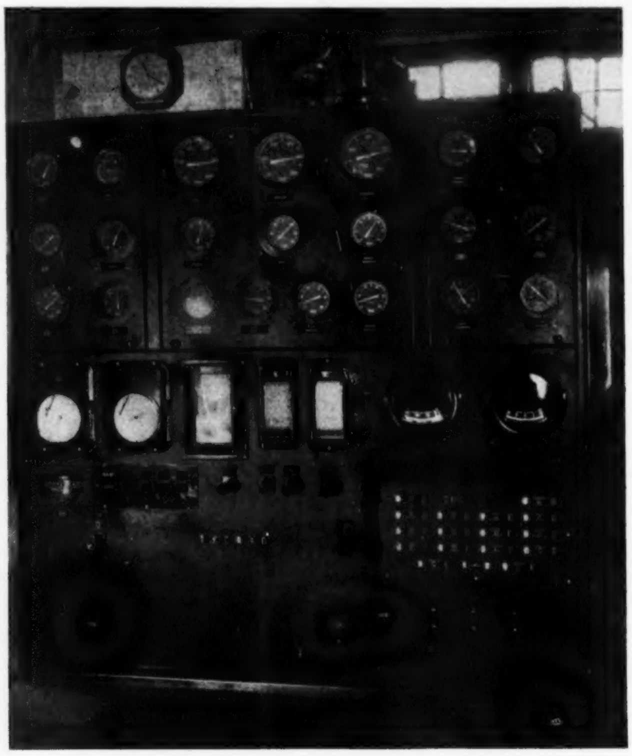


Fig. 3—Turbine gage panel

hand when starting the unit. It will cut in automatically whenever the oil pressure drops.

The turning gear oil pump is a vertical motor-driven centrifugal type and is provided primarily to furnish oil when operating on the turning gear, but it will automatically start upon failure of bearing oil supply, by means of a pressure switch, thus allowing the unit to be

Lubricating oil is returned into a spill from box which the oil flows into the reservoir through a series of three screens of increasing fineness. The last screen is 70 mesh, fine enough to hold small metallic particles which may be picked up by the oil in the bearings. Oil to the bearings is forced through a Cuno filter which is manually rotated once a watch to keep the disks clean.

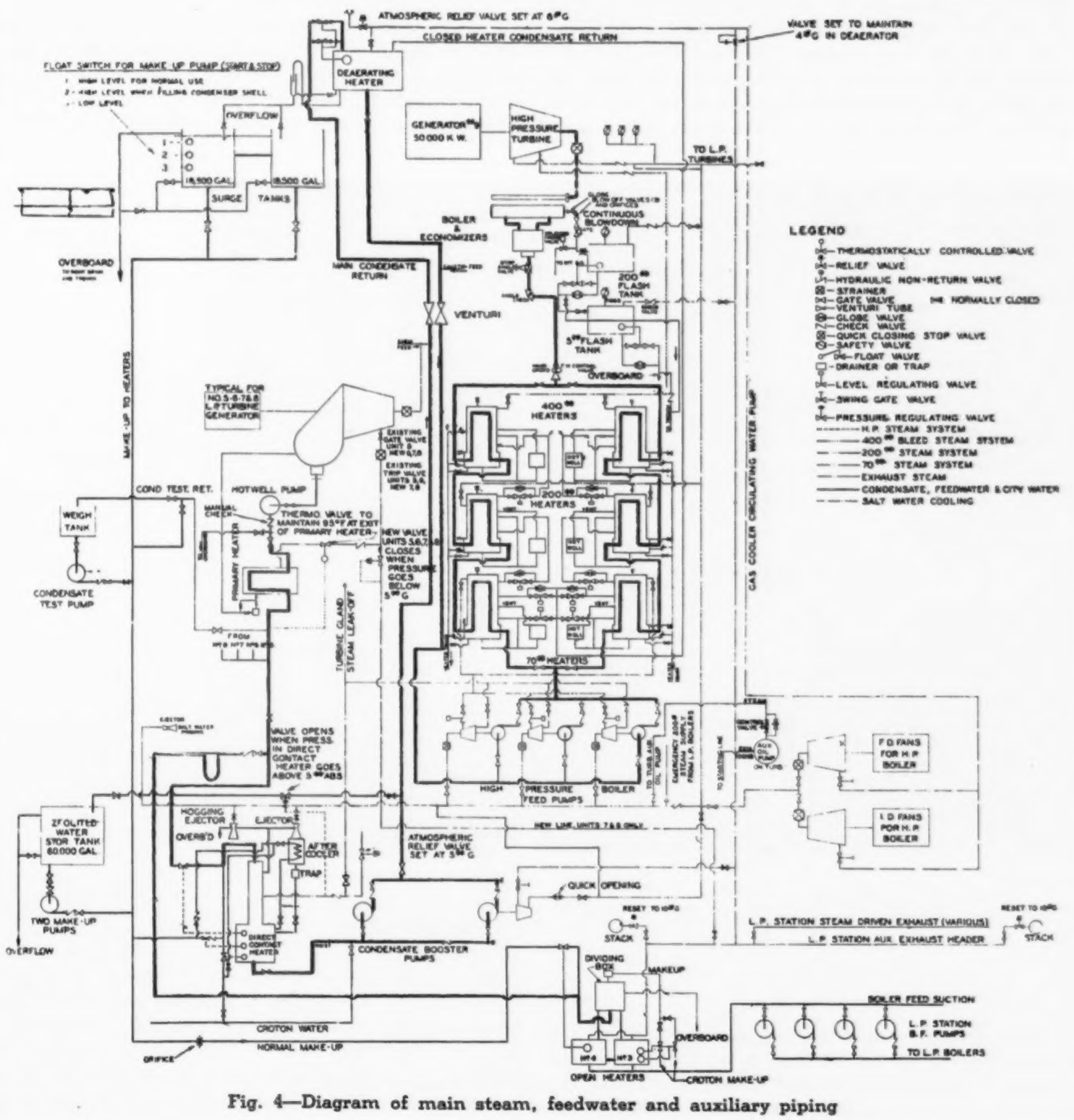


Fig. 4—Diagram of main steam, feedwater and auxiliary piping

shut down safely. This pump will start automatically only if the steam-driven pump fails to cut in.

Two oil coolers are provided in the main oil reservoir. These are so arranged that either or both may be in service depending on the position of the tandem three-way valve. However, one cooler is adequate for cooling purposes, even with river water temperatures as high as 75 F.

To eliminate oil and water vapors around the reservoir, a vapor extractor has been provided to exhaust these vapors and maintain a slightly subatmospheric pressure in the reservoir. The vapors are discharged to the roof.

To prevent the leakage of hydrogen through the shaft seals of the generator, special oil-sealed glands are provided. Oil is supplied to these glands by the gland-

seal oil pump at a pressure maintained by a differential pressure controller at 5 psi above the gas pressure.

Oil in contact with the hydrogen is drained to a defoaming tank where most of the entrained gas breaks out and is vented to the generator casing. The level in the defoaming tank is maintained by a controller which also seals the tank. Oil draining from the defoaming tank joins the air contaminated seal oil and returns to the vacuum-treating tank.

The heat picked up by the ventilating gas in the generator must be dissipated. In the systems installed by the Consolidated Edison Company this is done indirectly by river water. The heat is transferred to fresh water circulated through gas coolers, and then transferred from fresh water to river water in the heat exchangers. This system prevents any salt water from getting into the generator in case of a gas-cooler tube failure.

Condensate System

Condensate from the low-pressure turbine hotwell pumps is discharged into a common header feeding both the open heaters in the old part of the station and the direct-contact heater in the high-pressure section. The control is arranged to feed only condensate to the direct contact heater. All condensate over and above that required for the high-pressure system, and necessary make-up water, flows to the open heaters in the low-pressure station. At least two low-pressure boilers are in operation at all times to supply steam in case of emergency to drive the high-pressure boiler-feed-pump turbine, the main turbine auxiliary oil pump and for the direct-contact heater air ejectors.

The direct-contact heater is an Ingersoll-Rand vertical disk flow type, equipped with an integral precooling chamber, a storage hotwell, an ejector for normal operation and a hogging ejector for starting up. This heater operates at a pressure of 4 psi absolute, condensing approximately 20,000 lb per hr of exhaust steam from the high-pressure boiler-feed-pump turbines. In addition to condensate, this heater is provided with emergency connections for supplying treated water and city water.

Deaerator

For pumping condensate from the direct-contact heater to the deaerator, two condensate booster pumps, one motor-driven and one steam-driven (spare), have been provided. The deaerator is an Elliott contact tray type having a rated capacity of 1,100,000 lb per hour of condensate measured at the discharge. This heater has two vent condensers set in parallel and valved so as to permit either to be isolated for overhauling, without taking the deaerator out of service. Heating steam at approximately 3 psi gage is supplied from the nearby induced-draft and forced-draft turbine exhaust, the balance from the station auxiliary exhaust header. High-pressure closed feedwater heater condensate returns are also flashed into the shell above the water level.

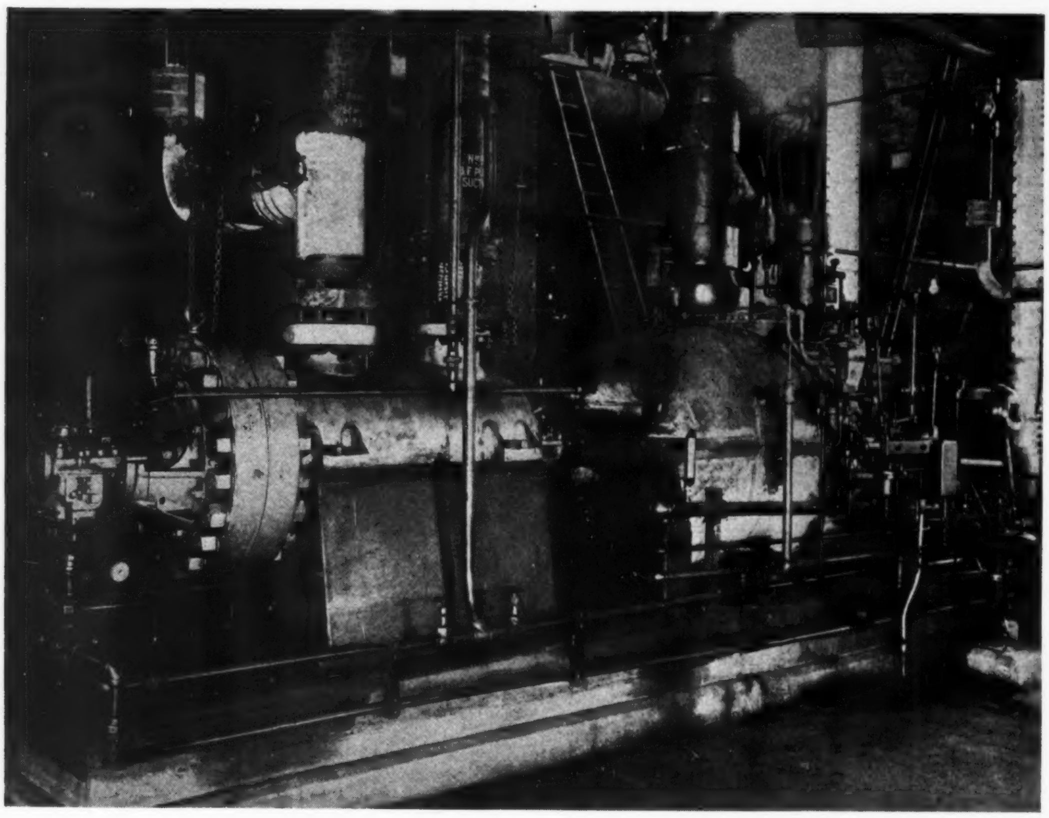


Fig. 5—View of one of three turbine-driven boiler feed pumps

Boiler Feed Pumps

Condensate at approximately 222 F flows from the deaerator to the suction of the high-pressure boiler feed pumps. The elevation of the deaerator is such as to maintain a positive suction head of at least 30 psi gage at the pumps. There are three turbine-driven variable-speed boiler feed pumps—two for full load operation and one spare. They are of Byron-Jackson design in-

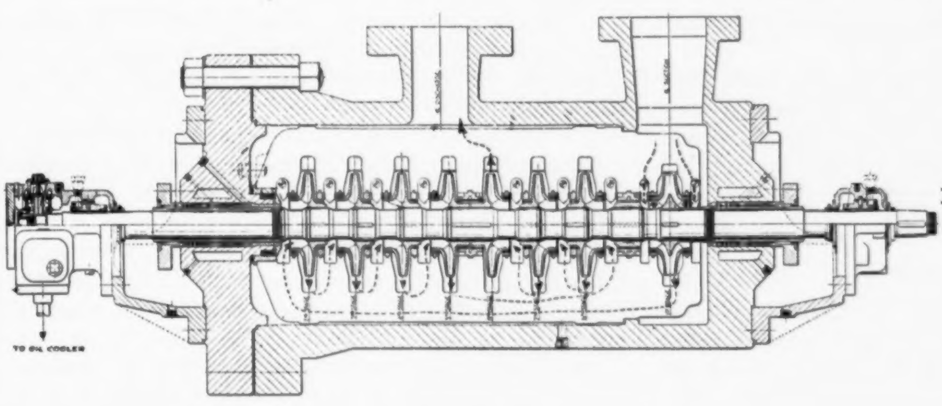


Fig. 6—Section through high-pressure boiler feed pump

volving an eight-stage outer barrel and horizontal split inner volute case. The space between the inner volute case and outer barrel is filled with water at full discharge pressure of approximately 1800 psi gage, so that the outer barrel alone withstands the bursting pressure and is subject to tension stresses. The inner case is the conventional horizontally split volute type utilizing the discharge pressure to maintain the joints. The volutes are of double construction to lessen the radial loads and losses at low capacities. The impellers are of the opposed enclosed type, one half having the suction entrance on one side and the other half on the other side. Any minor unbalance axial thrust is carried by an oversized Kingsbury thrust bearing.

The pump is so designed that in case of emergency it may be put into immediate service without warming up. However, a turning gear is supplied to rotate the unit at about 13 rpm for warming up periods. Normal full load capacity of each pump is 460,000 lb per hr against a total dynamic head of 1800 psi gage, at 4150 rpm.

Boiler Feed Control

There have been three means provided for controlling feedwater to the boiler; these are automatic, remote manual and local manual. The equipment is the Bailey Meter Company's three-element system and is arranged to regulate the speed of the boiler feed pump turbines. Included as part of the control are a steam flow recorder, feedwater flow recorder, and boiler drum level recorder. This three-element system is designed to vary the speed of the boiler feed pump turbines so as to maintain a balance of water flow against steam flow, compensated by drum level variation.

The automatic manual selector valve is on the boiler operating panel, located in the vicinity of the boiler feed pumps and affords a means by which the actuators at the feed pump turbines may be positioned manually from a remote point.

Local control of the feed pump turbines may be accomplished by means of a hand wheel above the dia-

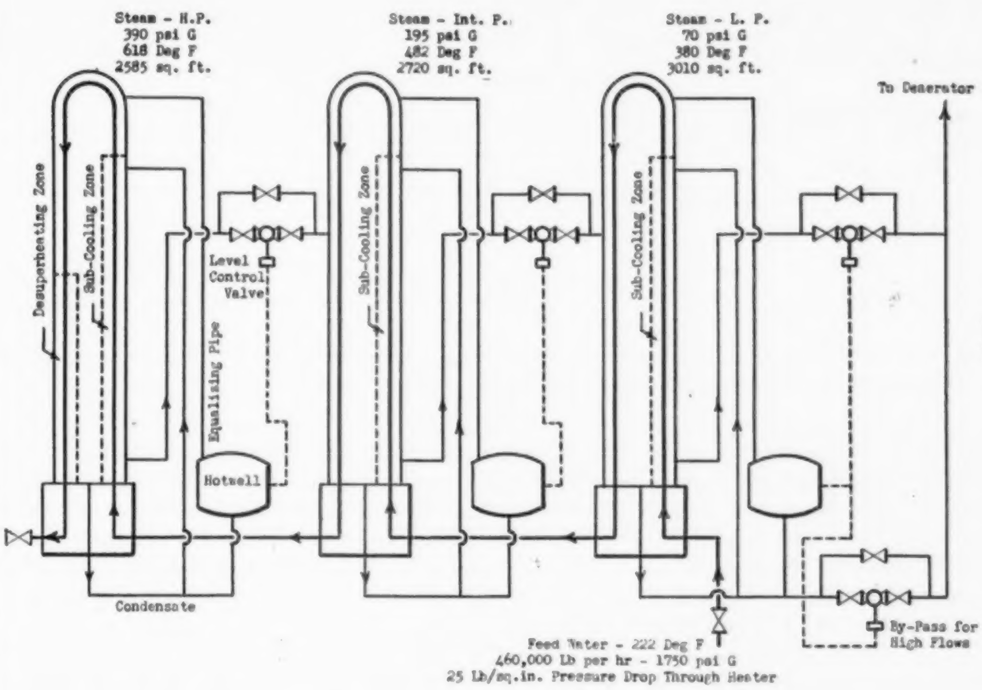


Fig. 7—Diagram of feedwater heaters and condensate flow

phragm chamber on the actuator. The drum water level is visible from these control points through the sight gage system.

There are no special control valves in the boiler feed piping other than the gate valves and a manually operated globe valve. This valve was installed to obtain satisfactory control during the initial tryout and adjustment period on the automatic control and is now left wide open.

Boiler-Feed Turbine

The boiler-feed-pump drive is a direct-connected, condensing, controlled-extraction type General Electric turbine having nine impulse stages—three above the steam conditions and 1.3 psi gage back pressure. This is the power required at one half load at full boiler pressure and is in excess of that required during normal starting where the boiler pressure will be low until after bled steam is required.

The turbine is provided with a turning gear so that the spindle may be rotated at a speed of about 13.8 rpm when the driven pump is acting as a spare. This is operated during standby periods so that the turbine may remain uniformly heated and the spindle true. The leakage through the throttle and control valves might otherwise distort the casing and spindle because of unequal temperature stresses.

The turning gear is driven by a 2 hp motor through a

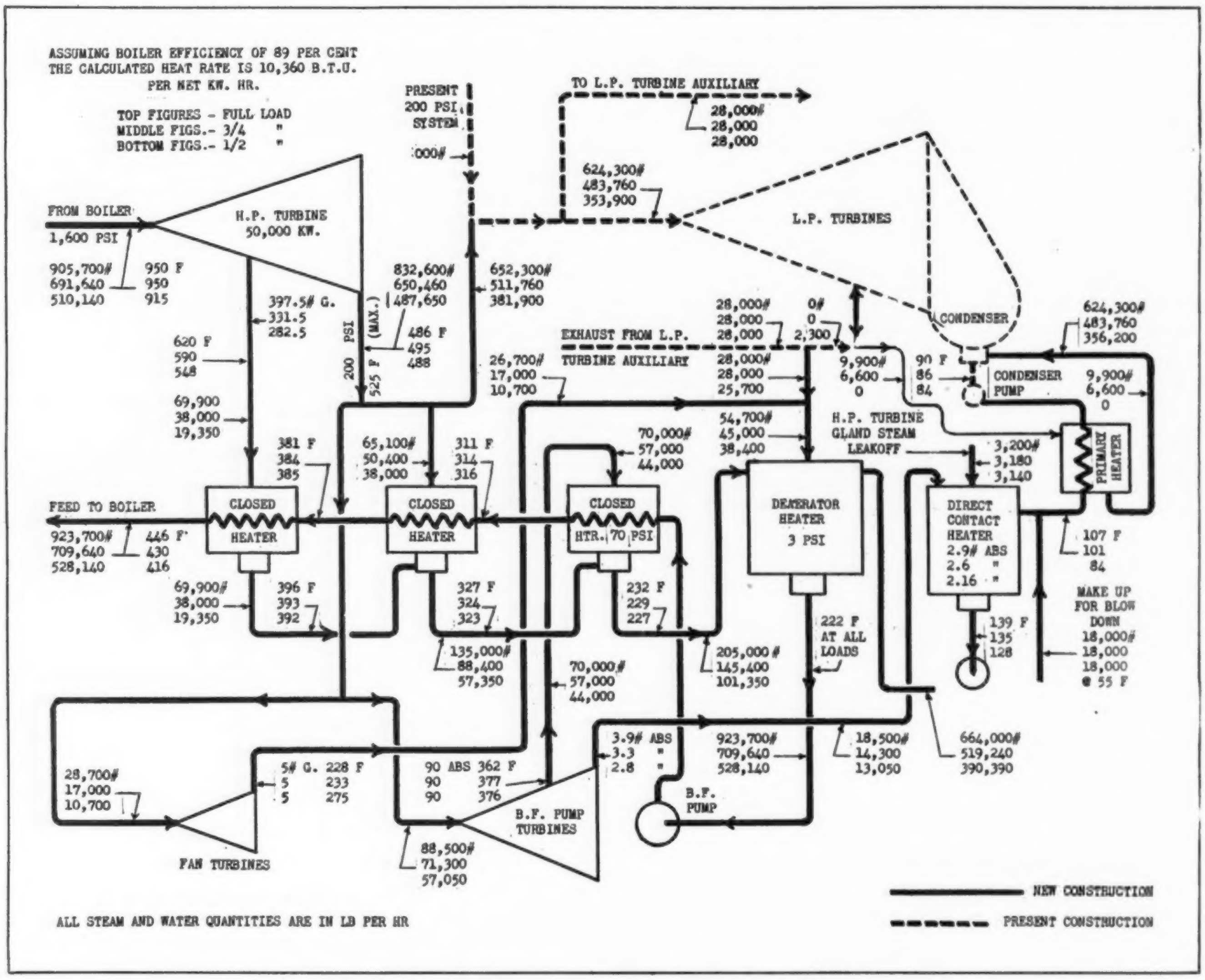


Fig. 8—Station heat balance; note calculated net station heat rate

bleed point and six below. It has a normal rating of 1357 hp at 4150 rpm with 185 psi 485 F steam to the throttle and exhausting into the direct-contact heater at 4 psi abs. It will develop a maximum load of 1685 hp at 4340 rpm with the same steam conditions. This capacity may be required when carrying full load with only one set of heaters in operation. To take care of a starting condition where the exhaust must be to atmosphere and no bled steam is required, the turbine has been designed to develop 738 hp at 3670 rpm with the same throttle speed reduction of 63 to 1. The worm shaft is extended to drive an oil pump which furnishes oil for control and bearing lubrication during turning gear operation. This oil pump also acts as a back-up for the shaft-driven main oil pump through the action of a pressure switch which automatically starts the turning gear motor on loss of oil pressure. The turning gear is manually engaged and automatically disengaged. During operation on the turning gear, the gate valve in the exhaust is open so that the pump may be started by opening the throttle

valve. The turbine glands are steam sealed, provision being made to use live steam from above the throttle valve seat during standby periods.

During normal operation, control and bearing oil is furnished by a geared type positive displacement, valveless pump driven from the turbine shaft at a speed about 15 per cent that of the turbine.

Flow of steam to the turbine is controlled by five poppet-type admission valves actuated by a spring-loaded piston. The flow of steam to the exhaust end is responsive to the bleeder pressure.

A hand speed-changer has been provided to allow manual control of the turbine speed when the automatic control is not being used. This hand control may be used to hold speed at any point between 3500 and 4500 rpm. When on automatic control, the speed changer is set at a speed slightly above the expected maximum required so that in case of failure of the automatic control the pump will continue to supply the required water at a slightly higher pressure.

The governing mechanism on these boiler feed pump turbines is designed so that the pumps will supply the required feedwater and at the same time the turbines furnish the necessary steam for feedwater heating in the 75-psi heaters. Pumping requirements are met by the connection to the Bailey feedwater regulator. Steam requirements for the heaters are met by the extraction pressure control which acts to maintain 75 psi in the extraction line, by adjusting the grid valve to allow more or less steam to flow to the low pressure end of the turbine. As an adjustment either by the Bailey regulator or the extraction pressure governor will require some compensating adjustment of the main control valves, the various controllers are interlocked.

Closed Feedwater Heaters

From the common boiler-feed-pump discharge header the water is pumped through two parallel rows of closed heaters. Each row consists of one low-pressure heater using steam at 70 psi gage from the boiler feed-pump bleed; one intermediate pressure heater using steam at 195 psi gage from the high-pressure turbine exhaust; and one high-pressure heater using steam at 390 psi gage from the high-pressure turbine extraction point. Under normal conditions, the total flow of feedwater is handled through both rows of heaters. However, the piping and valves are so arranged that in case of necessary outage one row can be isolated by gate valves set ahead of the low-pressure and beyond the high-pressure heaters. Under this condition full flow is passed through one row of heaters, resulting in an increased pressure drop.

These heaters are of the Westinghouse vertical "U"-tube removable shell type. Each is provided with an integral drain cooling section. In addition the high-pressure heaters are provided with a desuperheating section. The feedwater is admitted through the water boxes or "channels" and then through the tube circuit consisting of four passes. These channels are forgings with integral tube sheets, and are equipped with pressure-sealed covers, each cover consisting of four separate quadrants. The condensate drains down through the inlet head or water channel to a separate level-controlled hotwell, thence through external interconnecting piping to the lower end of the heater drain cooling section. From here the condensate is drained to the next lower stage heater.

The drain cooling section of the low-pressure heaters is designed to pass a maximum condensate flow corresponding to full load normal operation, and to bypass externally condensate above this figure, particularly when one battery of heaters is out of service. The drain cooling sections of the other heaters are designed to pass condensate under all operating conditions.

Diaphragm valves actuated by liquid-level controllers serve to regulate the flow of condensed steam from the six hotwells of the high-, intermediate- and low-pressure closed feedwater heaters so that a level of condensate will be maintained in each hotwell within a predetermined range of about six inches.

Except for a few shutdowns for minor adjustments, the equipment has been operating continuously and satisfactorily since its initial starting on April first of this year, and present indications are that the expected heat rate, as calculated in Fig. 8, will be attained.

Program for Annual Joint Fuels Conference

The Annual Joint Fuels Conference of the A.S.M.E. Fuels Division and the A.I.M.E. Coal Division will be held October 28–29 at the William Penn Hotel, Pittsburgh, under the sponsorship of the Pittsburgh Sections of the A.S.M.E. and A.I.M.E. Highlights of the Conference will be as follows:

THURSDAY, October 28

9:45 a.m.

Welcoming Address by Harry M. Moses, Pres. H. C. Frick Coke Co. Response by Harold V. Coes, Pres., A.S.M.E.

10:00 a.m.

Technical Session—Coal Research, Julian E. Tobey, Chairman, and Summer B. Ely, co-chairman.

"The Progress of Research in Coal Utilization," by E. R. Kaiser, Battelle Memorial Institute.

"Test Methods for Rating the Performance of Domestic Stoker Coals," by R. Helfinstine, Illinois Geological Survey.

"Selling Coal Research and Its Products"—Panel Discussion led by J. E. Tobey, Upper Monongahela Valley Assoc.

2:00 p.m.

Technical Session—Mining Management. D. L. McElroy, Chairman, and A. R. Mumford, co-chairman.

"Modern Training for the Miners at the Face," by G. R. Spindler, University of West Virginia.

"Coal Faces Post-War Adjustment," by R. M. Weidenhammer, Cosgrove Coal Co.

7:00 p.m.

Banquet. T. E. Purcell, Toastmaster.

Presentation of Special Guests.

Presentation of Percy Nicholls Award to Henry Kreisinger, Combustion Engineering Company, Inc.

Speaker, Gen. E. P. Sorenson, Asst. Ch. Army Air Force, Staff Intelligence, War Dept., Washington, D. C.—"Applications of Air Power."

FRIDAY, October 29

10:00 a.m.

Technical Session—Gas and Carbonization, H. H. Lowry, Chairman, and Martin Mayers, Co-Chairman.

"Utilization of Producers Gas in Industrial Furnaces," by D. B. Hendryx, Harbison Walker Co.

"Sources of Pressure Occurring during Carbonization of Coal," by G. C. Soth and C. C. Russell, Koppers Company.

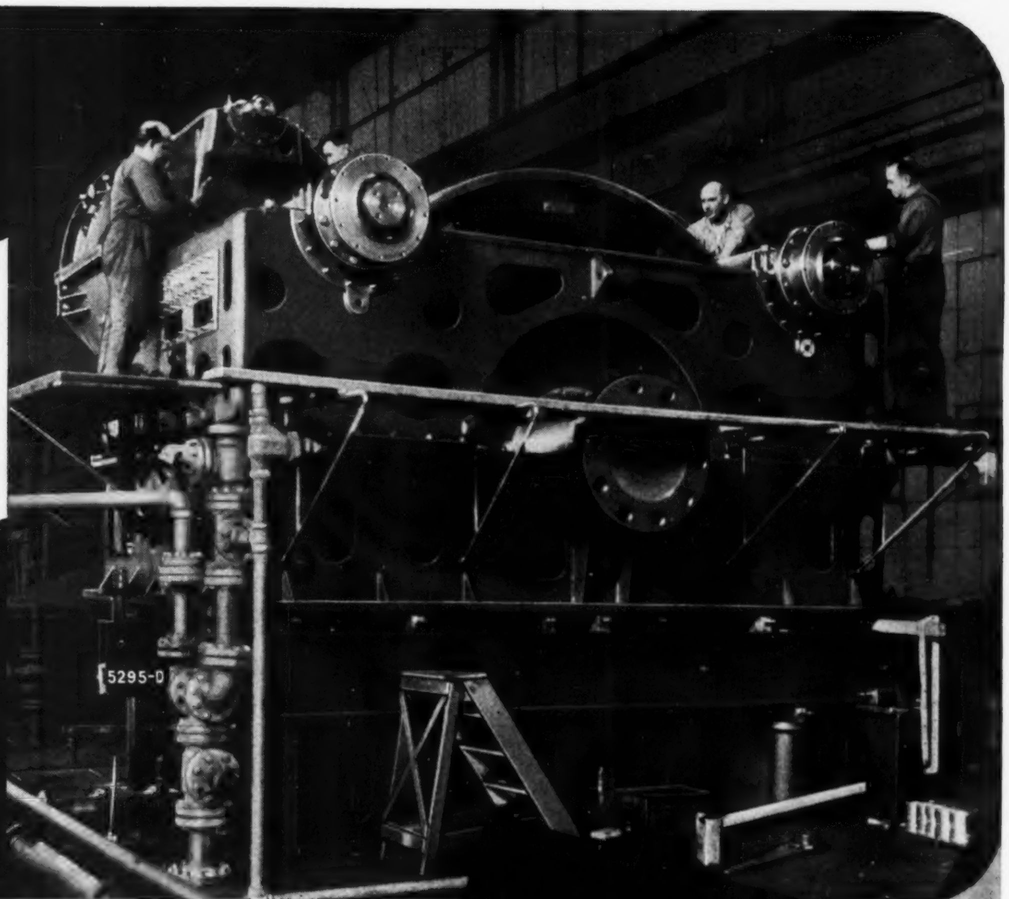
2:00 p.m.

Technical Session—"War Program," W. G. Christy, Chairman and J. D. Doherty, Co-Chairman.

"Laboratory and Field Tests on Coal-in-Oil Fuels," by J. F. Barkley, U. S. Bureau of Mines; A. B. Hersberger, Atlantic Refining Co.; and L. R. Burdick, U. S. Bureau of Mines.

Panel Discussion—"Trends in Fuels."

PARTS ARE GAGED *before and after* THE TEST RUN



Double helical ship propulsion gear on test floor at the De Laval Works

In the De Laval Works each part of a machine is manufactured to limit gages on an interchangeable basis and then, after assembly, the complete pump, compressor, steam turbine or gear is tested under operating conditions to make sure that performance guarantees are met and that the unit is mechanically perfect.

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M-30

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Collection and Disposal of Fly Ash from Spreader Stokers

By K. H. BOWMAN

Dravo Corporation

The following, which is from a paper presented at the 37th Annual Convention of the Smoke Prevention Association of America at Pittsburgh, discusses fly ash from spreader stokers and describes a helicoidal type of arrestor for installation in the base of the stack. Reinjection of the collected fly ash is discussed at length.

FLY ash is rarely, as the name implies, all ash but consists of as much as 40 to 70 per cent combustible matter. As these particles vary in size throughout a considerable range, not only the total amount but the maximum size in the gas stream depends upon the velocity of air through the fuel zone and furnace. Fly ash results from the burning of coal by any means, but the amount produced may be greatly increased where forced draft is used. However, the amount produced is dependent upon many factors, such as, percentage of ash in the coal, fusion point of this ash, control of air for combustion, type of firing equipment used, furnace temperature and furnace volume. The more attention that is given to the design and operation of the boiler furnace, the less attention will be required to deal with fly ash later. To this end let us review the principles of combustion and note how they can be made to apply with respect to the problem in connection with two commonly used types of firing equipment, namely, underfeed and overfeed, or spreader stokers.

The four essential factors of combustion are:

1. Mixture. It is necessary that the air supplied for combustion be thoroughly mixed with the fuel in order that the oxygen will be brought into intimate contact with all the combustible elements. In practice it is impossible to obtain a perfect mixture; therefore, in order to make sure that there is not a deficiency of oxygen, it is necessary to employ an excess of air over the theoretical requirements.

2. Air. The exact amount of air required for perfect combustion is dependent upon the analysis of the fuel. As mentioned, excess air should be provided but kept at a minimum, consistent with the balance between high efficiency and low maintenance.

3. Temperature. The rate of combustion is greatly increased at high furnace temperatures. Volatile matter in bituminous coal is distilled off and burned in the form of gas above the fuel bed. If the temperature of the furnace is below the ignition point of the gases, or they become chilled by contacting the colder heating surfaces of the boiler, they will not be completely burned but will be discharged out of the stack in the form of soot and smoke with a consequent loss in efficiency. This applies to the burning of small carbon particles suspended in the furnace gases as well.

4. Time. Although combustion is a very rapid process, a definite time is required to complete the burning of the gases or suspended fuel. For this reason it is necessary that there be sufficient furnace volume. It is essential that there be space for the gases and a large percentage of the suspended solids to become completely burned before entering the restricted passages or flues.

Let us apply these principles, first, to the underfeed stoker and then to the spreader stoker, and determine to what extent fly ash can be controlled. With the underfeed stoker, the coal, fed up from the bottom of the retort, is mixed with the air passing through the tuyères before the incandescent zone is reached. The ash, resulting from this combustion, is forced to the outer limits of the grate by the incoming coal and, if the temperature at this point is sufficiently high, it will fuse into a clinker. If, on the other hand, the fusion temperature of the ash is high and there is not sufficient temperature to form this clinker a considerable amount of fly ash will be produced, but its carbon content may be low. In order to remedy this condition, coal with a lower ash-fusion temperature can be burned or the grate area restricted to increase the temperature in this zone. Above the fuel bed there will be unburned volatiles and a certain percentage of small particles of carbon. Unless the furnace temperature is high enough, and there is sufficient time for these gases and carbon particles to burn before they come in contact with the boiler surface, smoke and coarse particles of fly ash will pass on through the boiler.

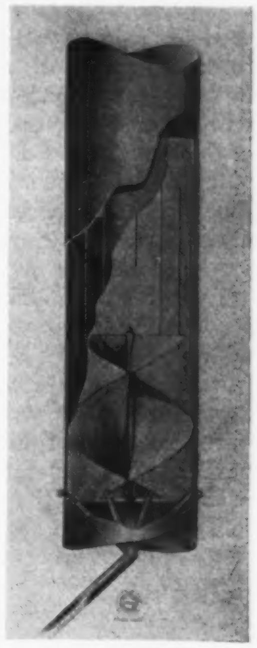


Fig. 1—Helicoid, slotted jacket and collection chamber

The spreader stoker is a machine which meets all the requirements for efficient combustion exceptionally well. The coal is introduced into the furnace over the grates; the fines are burned in suspension, and the larger pieces form a shallow fuel bed on the grates. Mixing of the fuel and air is most thorough and the larger portions which fall to the grates are thoroughly mixed with the undergrate air to produce proper combustion at that point. Additional over-fire air may be admitted through ports

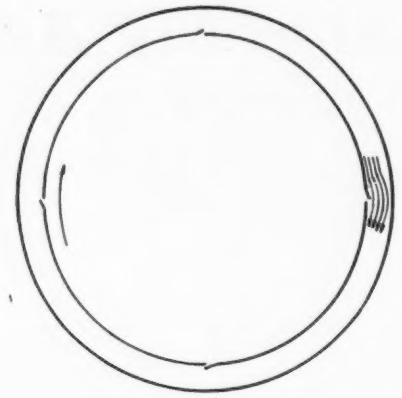


Fig. 2—Gases passing over slot projection inside ring produce slight suction

in the bridgewall, producing further turbulence. The ash formed on the grates is cooled by the supply of undergrate air to a temperature below the ash fusion point and formation of clinkers is prevented, insuring a uniform flow of air throughout the grate area.

With this type of firing it is relatively simple to control undergrate air automatically and thereby maintain the desired CO_2 content in the flue gas over long periods, thus meeting the requirement of proper furnace temperature. The factor of time is provided for by designing the furnace with sufficient head room above the grate, as with other firing equipment. One should not lose sight of the fact that turbulence, which is so necessary to provide the factor of mixture, also increases the time that the unburned particles of fuel are in contact with oxygen at a high temperature before they reach the cooler surfaces of the boiler.

Due to the inherent design of the spreader stoker, a far higher percentage of fly ash may be produced than with underfeed equipment. The actual percentage of carryover varies through wide limits depending upon such factors as size and burning characteristics of the coal used, burning rate per square foot of grate area, furnace temperatures, the general type, arrangement and proportion of furnace, and the manner of operation. On many jobs the carryover will be considerably less than 1 per cent, while on others it has been found to run as high as 6 or 8 per cent. Where the emission of this fly ash from the stack is objectionable, some means must be provided to remove such material from the stack gases.

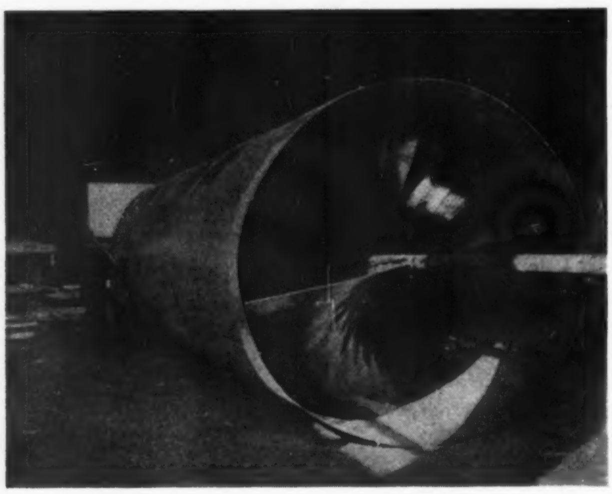


Fig. 3—Assembled arrestor unit

Fortunately, it is not necessary to provide means to collect all the fly ash produced in the furnace as there are several locations where it has a natural tendency to settle out—locations where there is a reduction in the velocity of the flue gas, a change in its direction of flow or a combination of both. In general, this tendency is most pronounced at the rear of the bridgewall of horizontal return-tubular boilers, in the rear pass of water-tube boilers and in the base of the stack.

The method to be selected for the removal of remaining fly ash from the stack gases will depend upon the percentages of such removals desired. The term fly ash is commonly used in a very general sense. It implies nothing as to the various sizes of the particles nor the percentage of each of these various sizes in the whole. As a matter of fact, a fairly large percentage of the particles may be so small as to have negligible nuisance value if they do leave the stack, as they travel farther and are distributed over a wider area. On the other hand, the larger and heavier particles will fall much closer to the stack and may constitute an appreciable nuisance. It would seem, therefore, that the problem is to remove such fly ash from the stack gases as may constitute a nuisance, regardless of just what percentages of the various sizes this may be. There are numerous pieces of equipment on the market designed to accomplish this but, for the purpose of illustration, the author has selected a mechanical type which has been used by his company extensively with considerable success.

Fig. 4—Test model showing whirling gas column at high velocity between jacket and wall

Fig. 5—Test model with reduced gas velocity indicating improved collection

This arrestor, Fig. 1, is basically a multiple-leaf helicoid, surrounded by a slotted jacket and concentric collection chamber. The helicoid makes a full 360-deg turn, and the pitch is a variable of design. In practically all cases a double-leaf helicoid is sufficient, but where conditions demand, three- and four-leaf helicoids, and even

multiple staging may be employed. The unit is placed vertically in the stack directly in the path of the exit gases; the bottom of the slotted jacket generally is not less than one full stack diameter above the top of the breeching opening. The basic essential in this arrestor is to create a whirling gas column between the slotted jacket and the outer wall or stack, in addition to the conventional rotary action of the main body of flue gases. This is accomplished by correct slot arrangement and spacing designed for the job involved and it is the result of the transmission of rotary gas action inside the stack to the gases within the annular ring which is the precipitating chamber. The top and bottom of the jacket are sealed and collected solids are drawn off from the bottom of the jacket through small tubes converging to one central down pipe, which is three to four inches in diameter.

The gases entering the arrestor are divided into two or more columns and given an even change of direction, by the use of the helicoids. The solid particles tend to follow a straight line and ultimately crowd on the under side of the leaves of the helicoid from where they are directed by gas flow to the sides of the circular slotted jacket. Here they are pulled through the slots by the whirling gas column, previously mentioned, where they precipitate out by gravity. Fig. 2 illustrates the manner in which the gases moving over the slot projection inside the ring tend to cause a low density, or slight vacuum at that point.

Fig. 6—Installation showing collecting hopper and tail pipe

The accumulation of solids in the whirling column definitely is not the result of a skimming effect, and any pronounced projection in the path of the rotating gases, inside the stack proper, causes turbulence that seriously affects the collection efficiency of the unit. Fig. 3 illustrates a shop-assembled arrestor unit, designed for installation within a brick stack.

The operation of this arrestor should not be confused with centrifuging as there is definitely not sufficient velocity of the gases for such a reaction. As a matter of interest, the best collection with this unit is obtained with a velocity of the gases around 900 ft per min, which is approximately the same as that through the tube bank

Fig. 7—Fly ash is reinjected from the three hoppers

of a boiler. Tests have shown that abrasive action of spreader-stoker fly ash does not become appreciable on the metal until a velocity around 1500 ft per min is reached. It is important to note that, inasmuch as draft loss is a function of velocity, the low velocity required through this collector results in a correspondingly low draft loss through the unit.

Some of the foregoing features of the arrestor can be shown by means of very interesting photographs. The models were constructed of transparent material and actual practice conditions were simulated as to draft, dust loading, etc. The fly ash was treated so that it would fluoresce under ultra-violet light. In Fig. 4 fly ash will be noted passing through the helix, the whirling gas column between the slotted jacket and the outer wall, and the fly ash descending toward the bottom of the arrestor jacket. The velocity of the gases in this test was excessive and it will be noted that a small quantity of the fly ash is passing out of the top of the model.

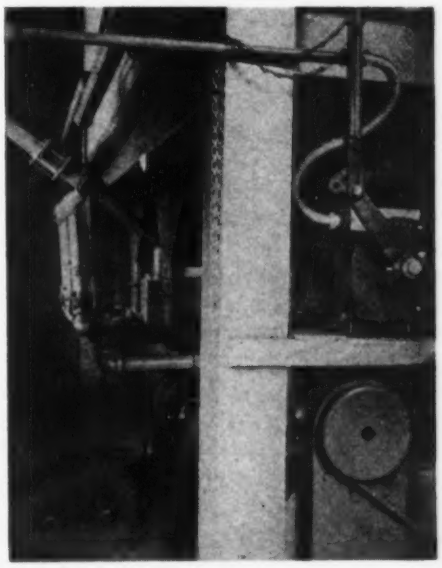


Fig. 8—Here the fan is connected to a header with branch lines to pick-up points

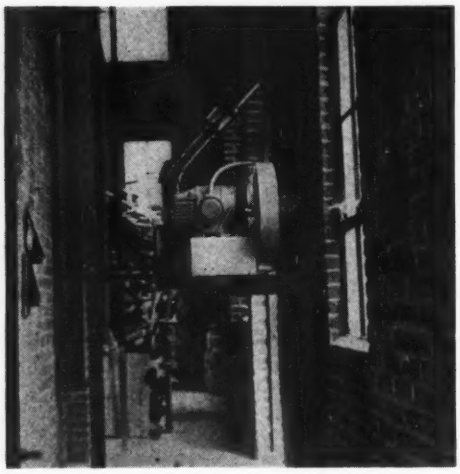


Fig. 9—A venturi nozzle provides the required air velocity

In Fig. 5 all conditions were the same as in the previous test, with the exception that the velocity of the gases was greatly reduced. Collection here has improved and emission of ash at the exit of the arrestor is practically absent. Horizontal units, following the foregoing principle, are designed to fit into a section of breeching if necessary.

Having collected the fly ash in various parts of the boiler and in the stack or breeching, the next problem is its disposal. The most satisfactory means of accomplishing this, without the use of costly equipment (except for large plants) is to reinject it into the furnace. If reinjection is performed properly, it is a practical method to use in connection with spreader stokers. The one fundamental principle of high furnace temperatures must be adhered to.

A considerable amount of fly ash can be burned within a very short period of time if the boiler is operating under normal load. If, however, there are appreciable periods when the load is light—which also means that comparatively little fly ash is being produced—no attempt should be made to reinject. The accumulation during such time should be stored and burned when the boiler load has again increased. Due to many variables existing with respect to both the design and operation of boilers, there is no fixed rule that can be followed in connection with the reinjection system, except, possibly, the one fact that a moving air stream should be provided to convey the fly ash. This flow of air may be produced by a steam or air jet, located either before or after the point of pick-up and the velocity of this air stream should be subject to control.

In the case of a typical three-drum, low-head, water-tube boiler with a fly-ash hopper under the rear pass, the fly ash may well be reinjected through the bridgewall. Where the collecting hopper is located in the base of a brick stack, with the down pipe from the arrestor entering at the top through a steel cover plate, fly-ash pick-up is a very simple arrangement; it is simply a tee of the same size as the conveying line. The tail pipe should always be carried to a point beyond where there would be any accumulation of fly ash, in order that a flow of carrying air may always be established. A similar pick-up may also be placed in the base of the stack, outside the fly-ash hopper, in order to remove all accumulation in this location. Fig. 6 shows an actual installation involving the principles mentioned.

Fly ash from the hopper below the rear pass is reinjected through the bridgewall by means of an air jet, the supply for which is normally obtained by bleeding off some of the air from the undergrate fan. This happens to be an installation where the boiler is operated at times at a very low rating and during which period no attempt is made to do any reinjection. As this particular undergrate fan is used in connection with a stoker installation where a very low undergrate pressure is required, it is not capable of developing more than $1^1/_4$ in. of static pressure. For this reason an auxiliary reinjection nozzle has been installed, using compressed air to start the movement of the large accumulation of ash.

A somewhat similar reinjection system is illustrated in Fig. 7. The boiler is of the same type as that just mentioned but fly ash is reinjected from three hoppers, instead of one, due to the greater width of boiler setting. The pick-up boxes shown at the bottom of the hoppers contain the air nozzles required to establish the flow of conveying air. The air supply for this particular reinjection system is supplied by a special fan designed for 7 to 10 in. pressure. This fan is connected to a header Fig. 8, from which valved branch lines are run to the necessary pick-up points. There is also a pick-up box connected to the sloping down pipe from the arrestor.

Illustrated in Fig. 9 is a method which was used to return the fly ash from an arrestor to the furnaces of two hrt boilers. The high-pressure fan used is the same as the one previously referred to. Here again the sloping down pipe from the arrestor to the pick-up box will be noted. Due to the fact that the fly ash picked up at this point had to be carried for some distance, a special type venturi nozzle was used to provide the required velocity of conveying air. In Fig. 10 will be seen the manner in which the discharge pipe from the pick-up box just referred to is carried to the front of the two boilers and discharged into the furnaces. As these boilers are usually run alternately, provision was made so that the fly ash could be reinjected into whichever unit was operating.

The principles shown in these various reinjection systems may be made to apply to practically all types of boilers and collection systems. The method to be selected in connection with a new boiler plant is a relatively simple matter; application to boilers already installed, however, presents many interesting problems.

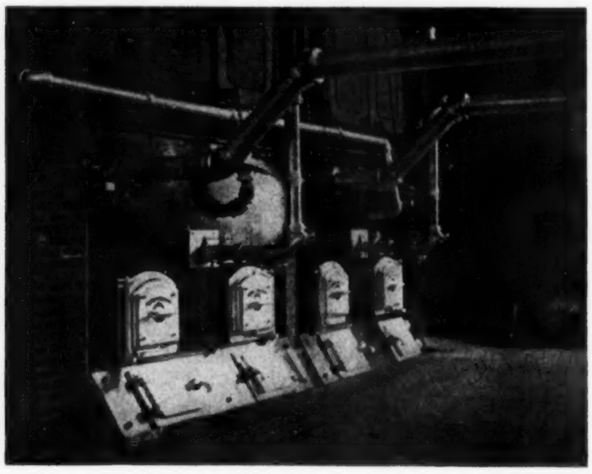


Fig. 10—Fly ash is here reinjected at fronts of furnaces

MANPOWER AND PRODUCTION

A group of engineering editors, including those of several power plant papers, was privileged recently to confer with various key individuals of the War Production Board and the Maritime Commission with a view to gaining authoritative background, without direct quotation, on the production situation and certain current problems. Although many of the matters discussed were foreign to, or only remotely related to, the power plant field, the following notes will afford a general highspot picture that may prove helpful to those interested.

WITH the second year of our participation in the War entering the last quarter, the major problem on the industrial front has shifted from materials to manpower, which is now causing widespread concern in view of lagging production in certain items.

Although the total requirements for steel, particularly carbon steel plates, are still greater than the supply, no essential part of the military program is, at present, handicapped on that score. While there has been a slowdown in the output of foundries, the alloy steel situation is reported as satisfactory. Copper is still tight, but demands for aluminum for essential use are being fully met even though many of the new aluminum plants are operating far below capacity because of labor shortage. In fact, the whole materials situation has been much improved through controlled distribution.

Up to June of this year approximately thirty-five billion dollars went into new plants and facilities, but the peak has long since been passed and such construction has been tapering off for many months. By the end of the year a further decline of 33 per cent in construction is scheduled. This, of course, also entails power facilities. Increased shipments abroad under "Lease-Lend" are taking up some of the slack in heavy equipment resulting from the curtailed construction. In some lines capacity was provided considerably in excess of that now actually required by the turn of military events, but this must be regarded as a precautionary measure. In other lines, however, present needs call for accelerated production and in these labor bottlenecks have been encountered, especially in certain localities.

Labor Bottlenecks

Despite inductions into the armed services, which to a considerable extent have been offset by the influx of women in war work, there would probably be sufficient man-power were it not for some unanticipated obstacles. For instance, the completion of many new plants in addition to easing the materials and equipment situations, has released thousands of workers in the construction field, but, in general, these men are reluctant to shift to the production line. As a consequence, certain groups are reported as bringing strong pressure to bear for the initiation of public building projects—a matter that should await the post-war slackening.

A second factor is that of shifting labor which seems impossible to prevent effectively, regardless of measures set up for its control. In one essential industry, alone, that employs 148,000 workers, there has been an average daily turnover of more than a thousand; and the time lost in training new employees has cut production to 65 per cent of that otherwise possible.

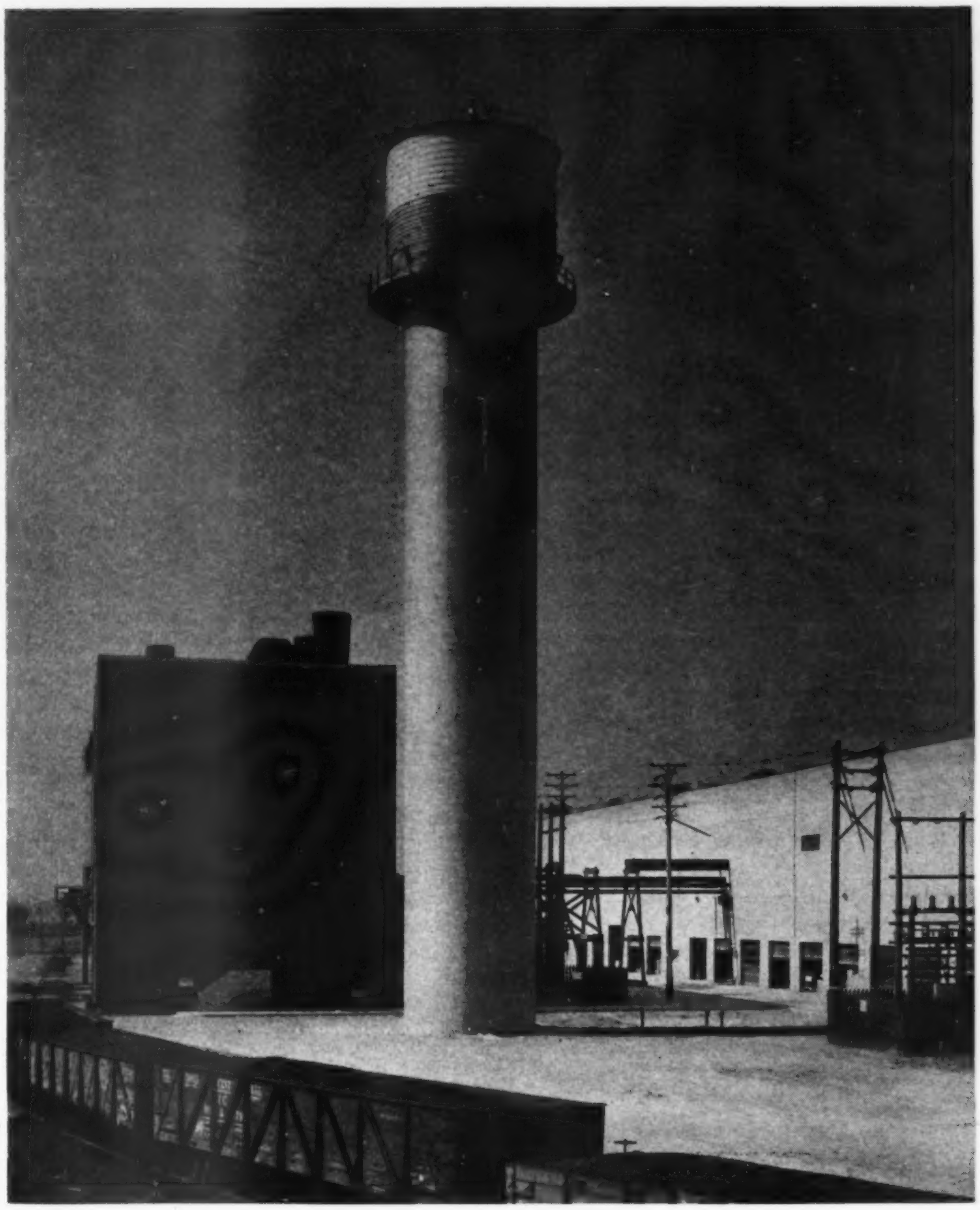
Again certain interunion regulations have in many cases prevented full utilization of the available manpower, but in a few isolated cases where such rules have been suspended by mutual consent of labor and management, production has been greatly increased without adding to the number of employees.

Added to the foregoing is a certain unwarranted feeling of complacency engendered by successes on the fighting fronts, despite warnings by the President and others in authority that the war is far from being won and our greatest efforts are still ahead. Later developments in the military situation on the Italian mainland are likely to emphasize these warnings to the American public.

Universal Service

While this situation tends to strengthen the argument for the enactment of universal service, considered opinion is that for such a step to be successful it would first have to be thoroughly sold to the American public. Indications are that instead of lending support to such a course, with its possible repercussions, the Government is determined first to exhaust the possibilities of curtailing schedules, shifting orders to non-critical labor areas and further equalization of wage differentials. This is revealed in the modified so-called "Buffalo Plan" which has lately been applied to war industries in certain critical labor-shortage areas. If these measures do not suffice universal service might be looked to as a last resort. Now that Congress has reconvened we may expect further discussion of the matter.

However, in certain other respects the picture is much brighter than it was a year ago. A splendid job has been accomplished in shipbuilding, both merchant and naval; and steam turbines, which then represented a serious bottleneck, are now reported as actually ahead of requirements in the marine field. Incidently, naval requirements, measured in terms of horsepower, are many times those of the merchant ship program, because of the higher speeds involved. The production of valves, which was inadequate some months ago is now proceeding satisfactorily and the marine boiler situation is reported as good. While gears and bearings are, at present, causing some concern, marine power plants appear to be keeping up with hull construction which is now up to 80 per cent of yard capacity. This is at present governed by the allocation of materials and the availability of welders, but the recent enlargement of the shipbuilding program is expected to increase this percentage.



Exit the Conventional Water Tank

The familiar steel water tank, mounted high on a framework of structural steel, which has become almost a symbol of American industry has been added to the long list of items for which steel is not available. That is why the attention of so many who view the huge Dodge Chicago Plant, Division of Chrysler Corporation, from a distance is first attracted by what appears to be a towering concrete silo. Instead, it is the first of two such tanks, located near the power plant and representing a new type of water tank construction.

Plans for this plant, where large airplane engines will be built, had already been drawn when the WPB ruled out the use of structural steel for new building and water tank construction. Albert Kahn Associated Architects and Engineers, Inc., in cooperation with Chrysler Corporation, who together designed the plant, promptly produced a modernized design that required less steel than ever before used in such a building and almost none in the two water tanks.

The tanks themselves are made of cypress. Each has a capacity of 100,000 gal and is mounted 125 ft above grade on a cylindrical tower of reinforced concrete. Over 60 tons of steel were saved by using concrete and wood.

But that was not all. Having been required to design a new type of water tank construction, the engineers proceeded to incorporate several notable advantages in it. They put the pump pit inside the base. No frost casing was necessary because the water pipes are entirely enclosed within the tower. There is also a ladder, with landings at intervals, inside the tower. And finally, provision has been made for hanging 100-foot lengths of a fire hose inside to drain.

A Useful Graph of the Properties of STEAM-WATER MIXTURES

THE chart on the opposite page illustrates graphically several interesting and useful relationships for mixtures of steam and water.

The study of circulation of water and steam in boilers and water walls, whether for the initial design or to diagnose the effect of variable operating pressure, requires a knowledge of the characteristics of the water and steam mixtures at any point within the tubes.

The chart is plotted with two parameters, namely: steam in the mixture by volume and steam in the mixture by weight. The steam in the mixture expressed as per cent by weight is also referred to as "quality," but this expression is most common when dealing with steam containing only a small amount of entrained moisture. The steam in the mixture by weight expressed as a decimal instead of in per cent is sometimes called the "dryness fraction." The reciprocal of the top dryness fraction is called the "circulation ratio," which is the ratio of the weight of water entering a furnace tube or wall, or bank of steaming tubes, to the weight of steam evaporated in the same unit of time. The chart provides a ready means of converting from one parameter to the other at any pressure.

The graph was plotted from up-to-date steam tables having values in accordance with the tolerances established by the Third International Steam Tables Conference. The specific volume of a steam-water mixture may be calculated from the following equation:

$$v_m = v_f + x(v_g - v_f) \qquad (1)$$

where:

v_m = Specific volume of mixture, cu ft per lb
v_f = Specific volume of saturated water, cu ft per lb
v_g = Specific volume of saturated vapor, cu ft per lb
x = Dryness fraction of the mixture or weight fraction of steam in the mixture.

(v_f and v_g are found in the steam tables.)

The mixture density is then $(1/v_m)$ expressed in pounds per cubic foot; and the density relative to saturated water is

$$(v_f/v_m) \qquad (2)$$

The steam in one pound of the mixture would have a volume equal to $x(v_g)$ and, therefore, the steam in the mixture, in per cent by volume, may be written:

$$x(v_g)/v_m \qquad (3)$$

For any pressure and steam to water ratio in the mixture, the density may be read on the ordinate scale, in terms of the ratio of mixture density to that of saturated water. When the mixture density is 0.50, it indicates that a one-foot-high column of the mixture would have only one-half the density of a one-foot column of saturated water in the downtakes, and, under these conditions, the available static head would be 0.50 ft per ft.

It is this static unbalance of head which produces circulation in a natural circulation boiler, but as soon as flow is established there is frictional resistance to be considered and the circuit will be in equilibrium when the available static head exactly equals the flow losses.

The true mean density of the steam-water mixture in the heated portions of a furnace circuit must be distinguished from instantaneous density values as may be determined from the chart. The former is an integrated mean of instantaneous values and must be determined in order to calculate the correct available static head for a given furnace wall. When the true mean density of the mixture is expressed as a ratio compared to saturated water, the chart may be entered at the ordinate value corresponding to the above ratio and, for any pressure, the volume occupied by steam in the generating tubes may then readily be determined. It is desirable to evaluate this item because it facilitates the calculation of (1) the level to which the water would recede if there were a sudden failure of fuel supply; or (2) the amount of water actually contained in the boiler under various conditions of steaming.

The effect of operating pressure on the available static circulating head will be readily perceived from the chart; for example, at 300 psi, 10 per cent steam by weight in the mixture is equivalent to approximately 90 per cent steam by volume and the density of the mixture is only about 10 per cent of the density of the saturated water; but, at 2600 psi, 10 per cent steam by weight is equivalent to only 30 per cent steam by volume, whereas the density of the mixture is 77 per cent of that of saturated water. This illustrates how the density and available static head would be affected by operating pressure for the same top dryness fraction or circulation ratio. But the lesser volume of mixture at the higher pressure would result in lower velocity and lower flow losses for a given flow area, so that the effect of operating pressure on net available circulating head cannot be judged from this chart alone.

If it is considered that the measure of tube protection is the volume of water in the mixture, then it is of interest to note that the lines labelled "steam in mixture, per cent by volume" are much flatter with respect to pressure than those drawn for "steam in mixture, per cent by weight." So, if one considers that 20 per cent water by volume leaving a circuit is adequate, the line drawn for 80 per cent steam by volume shows that at 300 psi the top dryness fraction would be approximated 0.05, requiring a circulation ratio of 20, whereas at 2600 psi the top dryness fraction would be 0.50 requiring a circulation ratio of only 2.0.

In the foregoing discussion, no consideration was given to the effect of "slip" between the steam and water composing the mixture. A theoretical discussion of "Slip Velocity in Boiler-Tube Circuits" appeared as an article in a recent issue[1] of this magazine.

[1] COMBUSTION, June, 1943 pages 40–43.

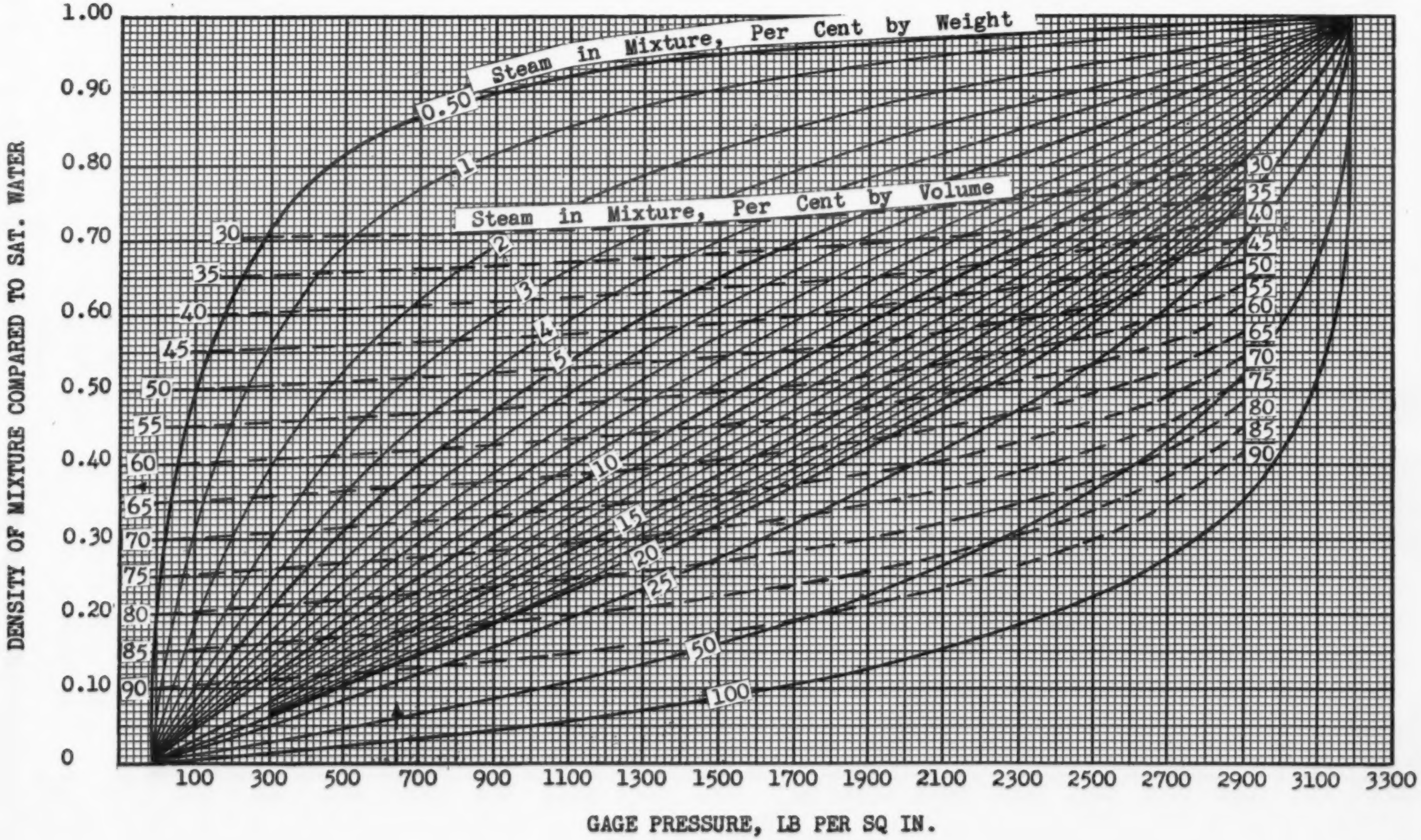


Chart showing relationships for steam-water mixtures

Fourth Annual Water Conference to Be Held at Pittsburgh

The Fourth Annual Water Conference of the Engineers' Society of Western Pennsylvania is scheduled for November 1 and 2 at the William Penn Hotel, Pittsburgh. The program will include a number of sessions arranged for topic discussion of formal papers by selected discussors. The tentative list is as follows:

Monday morning

Chairman, H. C. Miller, Public Service & Gas Corp.

"New Methods of Testing Oxygen in Boiler Feedwaters in the Presence of Nitrates" by Harold Staley, Cochrane Corp.

DISCUSSERS—C. E. Kaufman, Hall Laboratories; L. Drew Betz, W. H. & L. D. Betz; R. J. Coll, Beech Bottom Power Co.; M. C. Schwartz, Louisiana State University; H. C. Ulmer, Detroit Edison Co.; J. R. McDermet, Elliott Co.; R. C. Adams, U. S. Naval Experiment Station; S. F. Whirl, Duquesne Light Co.

"Approval Testing of Naval Deaerating Feedwater Heaters" by R. C. Adams, Naval Experiment Station.

DISCUSSERS—C. E. Joos, Cochrane Corp.; J. R. McDermet, Elliott Co.; J. D. Yoder, Permutit Co.; C. H. Fellows, Detroit Edison Co.; D. S. McKinney, Carnegie Institute of Technology.

Monday afternoon

Chairman, J. R. McDermet, Elliott Co.

"Paper on Corrosion" by L. F. Collins, Detroit Edison Co.

DISCUSSERS—S. F. Whirl, Duquesne Light Co.; Fred Owens, C. W. Rice Co.; D. S. McKinney, Carnegie Institute of Technology; F. N. Speller.

"Anaerobic Corrosion" by A. E. Griffin, Wallace & Tiernan Co.

DISCUSSERS—Arba Thomas, American Rolling Mill Co.; T. F. Wolfe, U. S. Cast-Iron Pipe Research Assoc.; C. D. Adams, Public Service Co. of Indiana.

Monday evening

Chairman, G. H. Young, Mellon Institute.

"Development in the Application of Geophysics to Ground Water Problems" by Dr. Carl A. Bays, Illinois State Geological Survey.

DISCUSSERS—Park A. Dickey; W. D. Collins, U. S. Geological Survey; B. B. Westcott, Gulf Research Laboratories.

Tuesday morning

Chairman, E. P. Partridge, Hall Laboratories.

"The Treatment of Cooling Waters" by L. Drew Betz, W. H. & L. D. Betz Co.

DISCUSSERS—Owen Rice, Calgon Inc.; Harry Einert, C. W. Rice Co.; R. B. Martin, Wallace & Tiernan Co.; J. A Holmes, National Aluminate Corp.; E Mandel, Commonwealth Edison Co.; S F. Whirl, Duquesne Light Co.; D. W Haering Co. representative.

"Experimental Studies of Boiler Scale" by J. A. Holmes, National Aluminate Corp.

DISCUSSERS—J. B. Romer or J. B. McElroy, Babcock & Wilcox Co.; C. E. Imhoff, Allis-Chalmers Mfg. Co.; Dr. Scott, Hall Laboratories; Prof. F. G. Straub, University of Illinois; W. C. Schroeder or A. A. Berk, U. S. Bureau of Mines; Mr. Long, Wisconsin Public Service Co.; Mr. Henry, Rochester Gas & Electric Co.

Paper by E. W. Scarritt, Elgin Softener Corp.

Tuesday afternoon

Chairman, F. J. Myers, Resinous Products Corp.

"Operating Data on Accelerator Softeners and Clarifiers" by A. C. Embshoff, Infilco Inc.

DISCUSSERS—H. C. Boehmer, Permutit Co.; C. E. Joos, Cochrane Corp.; J. J. Felsecker, Graver Tank & Mfg. Co.; W. R. Thomas, Carbon & Carbide Corp.; R. C. Bardwell, C & O Railroad.

"Latest Developments in the Removal of Cations and Anions from Water by Demineralizing" by H. L. Tiger, Permutit Co.

DISCUSSERS—A. C. Embshoff, Infilco Inc.; R. E. Joos, Cochrane Corp.; W. S. Morrison, Illinois Water Treatment Co.; J. F. Myers, Resinous Products & Chemical Co.

Energy Output Continues Upward

Output of electric energy by the principal utility systems of the country during July 1943 is reported by the Federal Power Commission as totaling 18,235,656,000 kwhr, a gain of 17.1 per cent over the same month last year. It was the highest monthly production on record. Corresponding peak demands aggregated 34,253,614 kw with an installed capacity of over 48,213,262 kw. This represented an increase in peak demand of 15.1 per cent over July a year ago. The greatest percentage increase, both in energy output and in peak demand, was in the south central section of the country. Of the total, fuel-generated power constituted two-thirds.

Slightly more than 6,780,000 tons of coal were burned during the month; the fuel oil was up 12.5 per cent over that consumed in June and the gas consumption showed an increase of 10.1 per cent.

The accompanying chart shows the production of electric energy by twelve-month periods for the last five years, the slope of the lines showing a steady increase since January 1939. Revised estimates for the year 1943 reach 214,435,487,000 kwhr, with a December peak of over 37½ million kilowatts, which would appear to leave a safe margin between that and installed capacity.

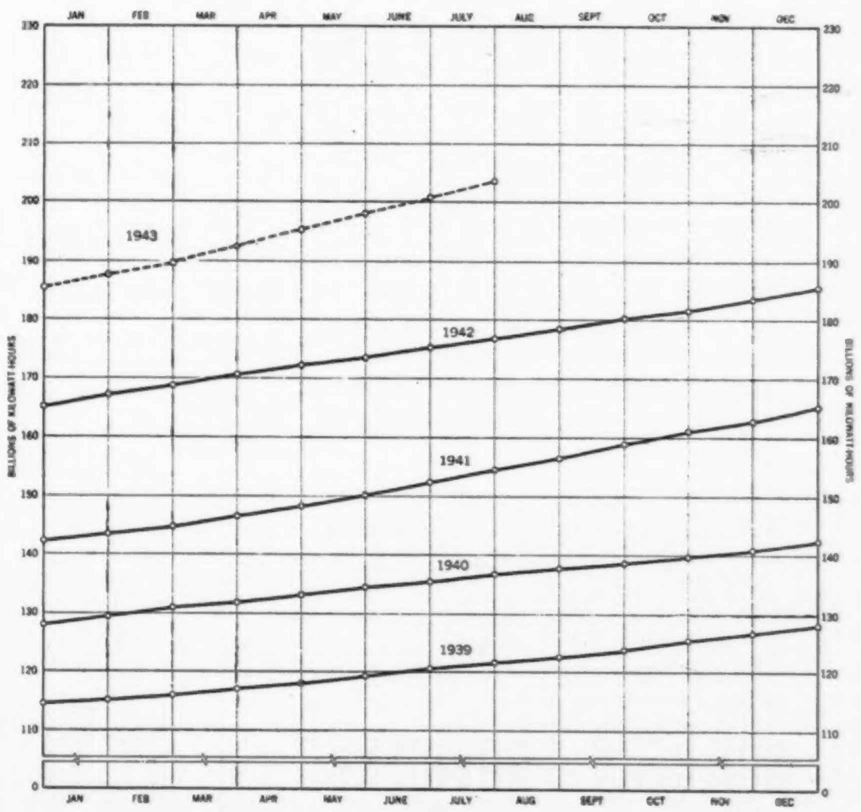


Chart shows steady increase in output since 1938

F. H. Rosencrants Dies

Fay H. Rosencrants, Vice-President of Combustion Engineering Company, Inc., died of a heart attack at his home in Scarsdale on the night of August 26 at the age of 54. He was internationally recognized as an authority on steam power plants and boiler design. As head of the Marine Department of his concern, he had been directing the manufacture of boilers for the United States Maritime Commission and the United States Navy.

Born in Cozad, Neb., Mr. Rosencrants was graduated from the University of Nebraska with a mechanical engineering

degree in 1911. He became a member of the faculty of Oregon State College and in 1916 became engineer for the Texas Power and Light Company at Dallas. From 1918 to 1924 he was connected with the Electric Bond and Share Company, in charge of designing steam power stations.

In 1924 he went to England to become Director of Engineering for the International Combustion Engineering Company, Ltd., London. In this capacity he supervised for six years the design and construction of notable steam power installations in Great Britain, Africa and the Orient.

Returning to the United States in 1930, he became Vice-President of Combustion Engineering Company, and was in charge of some of the Company's most important activities, including the development of the standard VU design of steam generator for a wide range of capacities, and the development of chemical recovery units for the paper mill industry. He was also identified with the design of the first large high-pressure forced-circulation boiler to be installed in the country—the 650,000 lb per hr, 2000 psi unit placed in service at the Somerset Station of Montaup Electric Company about two years ago. In recent years he was in charge of the Company's Marine Department, and his able administration has been an important factor in the handling of a vast volume of work for the U. S. Maritime Commission and the U. S. Navy.

Mr. Rosencrants was a frequent contributor of technical papers to engineering publications. He was a member of the American Society of Mechanical Engineers, the British Institute of Electrical Engineers, the Engineers Club in New York, the Propeller Club and the Whitehall Club in the same city, and also the Knollwood Country Club in Westchester County.

He leaves a widow, Mrs. Mabel Worcester Rosencrants, and two sisters, Mrs. I. A. Gilbert and Mrs. Ralph Robinson, both of North Platte, Neb.

Exploiting Power in Nazi-Occupied Countries

Nazi big business, reports the Office of War Information, is rapidly swelling the profits of plunder through the appropriation and exploitation of the electric power resources and light metal industries of the occupied countries. Norway and the Balkans offer the best spoils in these fields.

A number of new companies have been set up by those high in the Nazi Party, which share the profits of electrical development in eastern Europe with older German concerns. Energiebau Ost G.m.b.H. in Berlin was founded in the winter of 1942 for the planning and control of the reconstruction and extension of the power plants in the newly occupied territories in the East, the purchase of machinery, tools and raw materials required for this purpose, as well as the control of German and European electrical and boiler construction firms for the reconstruction of the power plants. The Board of this firm includes both important Nazi state officials and industrialists. At the same time some of the older German firms are getting their cut of the electrical profits.

Joint Meeting With Canadian Engineers

A joint meeting of the A.S.M.E. and the Engineering Institute of Canada has been scheduled for September 30 through October 2 at the Royal York Hotel, Toronto, Canada. High spots of the meeting will be sessions on Post War Planning and Production Engineering, the former scheduled for the evening of September 30 and the latter for Saturday morning, October 2. However, there will also be sessions on Steam Power, Transportation, Conservation of Materials and Manpower Utilization.

At the Steam Power Session on Thursday morning, the scope of discussion will deal with changes in steam-generation principles, particularly marine, as brought about by the war, and their effect on post-war power generation. Two papers are scheduled, namely, "Effect of This War on Steam Generation," by E. G. Bailey, and "The Field for Steam Power in Canada," by Henry G. Acres.

At the dinner on Friday evening, the principal speaker will be Charles E. Wilson, Vice-Chairman of the War Production Board.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

Darling Valve Catalog

This new 324-page industrial catalog, announced by the Darling Valve & Mfg. Company, embodies special features in valve cataloging and engineering data, with particular emphasis on readability and indexing for ready reference. With a page size of $7^3/_4 \times 10^3/_4$ inches, bound in durable blue covers and containing over 600 photographs, sectional views, designs, detail drawings and diagrams, together with numerous technical contributions by some of the best talent available, this volume is intended to provide a valuable valve handbook for use in plant design, construction and maintenance.

Electric Instruments

A new General Electric publication (GE T-1173), entitled "Electric Instruments, Principles of Operation," presents a concise discussion of the characteristics of instruments, what makes them operate, and the individual limitations of the various types. Electric instruments are defined simply as the tools for obtaining essential information about electric circuits. Thus, a study of their construction and application invariably points the way to lower costs and improved manufacturing methods. The text is accompanied by numerous diagrams and a few photographic illustrations.

Filters

The Cuno Engineering Corporation has issued a colorful 36-page bulletin describing the operation and application of its Auto-Klean and Flo-Klean filters. Much of the space in this bulletin is devoted to specific fluid filtration problems, describing the filter supplied and its operation. Numerous photographic illustrations accompany the text.

Magnetic Pulley Maintenance Manual

A new 40-page handbook on the operation and maintenance of magnetic pulleys has been published by the Dings Magnetic Separator Company. Chapter headings include: Magnetism; Electromagnets; The Magnetic Pulley; Operator's Guide; Trouble Chart; Electrical Maintenance; Mechanical Maintenance; Belt and General Maintenance. A discussion of magnetic theory is included as a background for the practical suggestions offered. The publication is liberally illustrated with drawings and diagrams, and includes a number of simple formulas, a pulley selection table and other data.

pH Recorders

Leeds & Northrup Company has issued a new 16-page catalog (N-96-1) describing apparatus for indicating and recording pH values. The equipment consists of an L&N glass electrode assembly wired to a Micromax recorder which continuously measures pH of the process. Illustrations include installation views, the electrode assembly and full size sections of rotating and strip charts.

Photocopy Machine

A folder has been received from the American Photocopy Equipment Company describing the uses of its "Apeco" device for making facsimile copies of anything written, printed or drawn. The machine measures $12 \times 12 \times 24$ inches, operates on a-c or d-c current, and weighs only 10 lb.

Proportioning Equipment

Proportioneers, Inc. has issued a new 8-page bulletin (No. 1700) describing its complete line of constant rate and flow responsive proportioning equipment. The bulletin contains flow diagrams showing many applications including water treatment and boiler water conditioning, blending ingredients in the production of plastics, synthetic rubber, lubricating oil, etc., and also diluting and sampling processes.

Recording Thermometers

A new Bulletin, No. T800, with forty pages of useful and technical information on thermometry and thermometers has just been published by The Bristol Company. The bulletin describes their line of recording thermometers with considerable space given to the basic theory of the several types offered, as well as practical information regarding ranges, charts, bulbs and tubing available.

Water Treatment

D. W. Haering & Company, Inc. has published a 48-page booklet of articles on scale, corrosion and water treatment problems. The booklet is profusely illustrated and includes tables, charts and graphs on water problems occurring in cooling systems, hot water systems, boilers, and return systems, with special data on corrosion inhibitors, scale preventives, protective coatings, proportioning equipment and refrigerating brine problems.